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COMPARATIVE STUDY OF PHYSICAL AND BIOCHEMICAL CHARACTERISTICS OF GUAVA FRUIT (*PSIDIUM GUAJAVA* L.) CVS 'GOLA' AND 'SURAHI' DURING SUMMER AND WINTERSEASON

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Under subtropical climatic conditions guava can produce two crops i.e. summer and winter crops in a year. In certain guava producing areas of the country, growers scarify the summer crop to get a heavy winter crop. However, presently very little is known in literature about the physico-chemical quality profile of guava fruit produced in the winter and summer seasons.The study was undertaken to investigate the comparative fruit quality of guava during summer and winter seasons. The study was carried out on two guava cultivars i.e. 'Gola' and 'Surahi'. Data regarding physical parameters (size, weight and firmness) and biochemical [Soluble Solids Contents (SSC), Titratable Acidity (TA) and Ascorbic Acid (AA)] fruit quality characteristics was collected. In summer 'Gola' showed significant results in fruit firmness, titratable acidity as compared to 'Surahi'. Only few parameters i.efruit length and ascorbic acid in 'Surahi' showed significant results than 'Gola' while other parameters like fruit width, fruit weightand SSCwere non-significant. As a whole, fruit harvested during winter season exhibited better quality and appearance than summer.
Keywords: Guava, Gola,Surahi, Physical parameters, biochemical quality, Fruit Quality

INTRODUCTION

Pakistan is blessed with diverse agro-ecological conditions which favor the production of a great variety of fruits and vegetables. Especially fruits and vegetables are very important portion of drinks (Shakeel *et al.*, 2013). Among fruits, guava has a prominent position in the fruit industry of Pakistan and ranked 4th on the basis of area (63 thousand ha) and production (555 thousand tons) (Anonymous, 2008). Among different provinces, Punjab contributes the major share in guava production in Pakistan with 49 thousand ha area and 445.5 thousand tons production (Anonymous, 2008). The world production of guava was 4035.5 thousand tons in 2004 (FAO, 2004).

Guava is one of the attractive fruit in appearance, shape, fragrance and nutrition. It has excellent nutritive value, flavor and medicinal properties and show great potential for processing into valuable products. Red guavas can be used as the base of salted products such as sauces, constituting a substitute for tomatoes, especially for those sensitive to the latter acidity. The fruit is sweet and eaten raw or cooked. It makes good jam and is universally known for its jelly. It is a richsource of vitamin C than ber, citrus and apple (Divya and Kumari, 2009). Guava, often marketed as 'super fruit', depending upon species, containing vitamin A, potassium, megnecium, four times more ascorbic acid than orange (200 mg $100g^{-1}$), and generally a broad low caloric profile of essential nutrients.It has been reported that in guava fruit the level of SSC ranged from 9.60 to 11.14%, titratable acidity from 0.28 to 0.38%, ascorbic acid from 167.50 to 210.00 mg 100 g^{-1}, total sugars from 7.93 to 8.90%, reducing sugars from 5.04 to 5.49% and acetic acid from 55.40 to 122.13µmol kg^{-1} (Archana and Siddiqui, 2004; Aulakh, 2004; Bal and Dhaliwal, 2004; Singh and Dhaliwal, 2004).

Guava is one of the most important tropical and subtropical fruit because it has a high nutritive value. It bears fruit twice i.e summer and winter in a year but the best quality fruit is obtained in winter (Bal and Dhaliwal, 2004). Winter crop comes from flowers after the rainy season i.e. September-October and ripens in winter (December-February). A second crop is produced during summer season from flowers which appear in early spring (Ginai, 1968). In Pakistan the winter crop is more popular among the consumers due to free from the attack of fruit fly. Due to poor orchard management practices, the guava orchards are facing some physiological disorders. Different diseases like wilt and canker; insect pests like fruit fly are also involved in the deterioration of the tree vigour and fruit quality. Fruit fly severely affects the summer crop resulting in significant loss in yield of most of the guava growers. Guava is the preferred food host of fruit fly. Most of damage is caused by the larvae, which feed inside the fruit (Norrbom, 2001). That is why, in certain areas of Pakistan, people get rid of summer crop by physical beating of trees at flowering or at

initial fruit set stage. In addition, the variations in the climactic characteristics of both seasons also leads to the significant differences in the quality characteristics of guava fruit. The fruit born in summer are insipid, watery and do not keep well (Ginai, 1968).

At present in Pakistan, very little information is available about the physico-chemical quality profile of guava during summer and winter seasons. Hence, the proposed experiment will be conducted to study the comparative fruit quality of two commercial guava cvs. 'Gola' and 'Surahi' during summer and winter seasons grown under the agro-climatic conditions of Faisalabad.

MATERIALS AND METHODS

The experiment was conducted at the Experimental Orchard Square No. 9 (31°25'N;73°09'E), Institute of Horticultural Sciences, University of Agriculture, Faisalabad. The laboratory work was carried out in the Pomology Laboratory, Institute of Horticultural Sciences, University of Agriculture Faisalabad (31°30'N; 73°10'E). Thirty trees of guava having uniform size, age, vigour and health planted in square system were selected for the experiment. Data regarding fruit quality parameters (physical and biochemical characteristics) was collected at 15 day's interval. The experiment was laid out according to Randomized Complete Block Design (RCBD).

Physical characteristics

Fruit weight (g): Weight of fruit was taken by using digital balance and expressed as (g) was recorded as fruit volume and was expressed as (ml).

Fruit size (mm): Four fruits were selected from each experimental unit. Fruit size was taken by measuring the fruit length and diameter of each sample.

Fruit length (mm): Fruit length was measured with the help of Vernier Caliper. It was expressed as (mm).

Fruit width (mm): Fruit diameter was measured with the help of Vernier Caliper. It was expressed as (mm).

Fruit firmness (lbs): Fruit firmness was measured with the help of penitrometer. It was expressed in pounds (lbs).

Biochemical analysis: Biochemical analysis of the pulp was done to study the different components of fruit quality i.e. soluble solid contents (SSC), titrable acidity (TA), Sugars (total, reducing and non-reducing) and ascorbic acid (AA) contents. To study the biochemical characteristics of guava fruit, 20 g pulp was homogenated in 40 ml distilled water by using the juicer blender. That homogenate was used for the further analysis of biochemical characteristics.

Soluble solid contents (^{o}Brix): A digital refractometer (RS-5000 Atago, Japan), was used to measure soluble solid contents (SSC) of juice.

Titratable acidity (%): Titrable acidity (TA) of fruit juice was deterrnined by method given by Hortwitz (1960). The results were expressed as % citric acid.To determine TA calculations following formula was used:

TA (%) = 0.1NNaOHused*0.0064*100*dilution factor / Volume of sample used

SSC: TA ratio was calculated in each sample by dividing the SSC with TA.

Ascorbic acid (mg100 g^{-1}): Ascorbic acid contents of juice were determined following the method described by Ruck (1961). The vitamin 'C was calculated by using formula given below:

Ascorbic acid (mg100 g^{-1}) = R_1 x V x 100 dilution factor / RxWxV_1

RESULTS AND DISCUSSION

Physical fruit parameters

Fruit size (mm): Table 1 showed that width of guava fruit in both winter and summer season revealed non-significant results at 5% significant level.While fruit length showed significant results.Surahi cultivar (81.64 mm) in winter and (49.74 mm) in summer showed more length as compared to Gola (62.32 mm in winter and 37.63 mm in summer). During the different intervals of fruit sampling both cultivars showed different trends as in summer season 'Surahi' showed maximum (59.02mm) at 3rd sampling period on 26th September, 2011 while minimum value showed on 25th August, 2011. 'Gola' at fourth fruit sampling interval (12th October, 2011) revealed maximum fruit length (43.16mm) while 34.37mm was the minimum fruit length on 10th September, 2011 (Fig 1).

In winter season (2010-11) maximum fruit length (81.39mm) was observed by 'Surahi' on 28th January, 2011) and 92.50mm fruit length on 25th January, 2012 (Fig.4.13). On an average 'Surahi' exhibited maximum fruit length in all three seasons (Table 2).

Similar results were showed by Shah (2012) who revealed that during winter 2009-10 to winter 2010-11 length was higher than summer crop and cv. 'Surahi' showed more size as compared to 'Gola'. It is clear from the data that maximum fruit length was obtained in winter fruits. However, maximum fruit length in 'Surahi'was may be due to more food reserves availability in winter.

Fruit weight (g): In summer season fruit weight showed non-significant results (P≤0.05) but highly significant results were seen in winter season at 1% significant level. Surahi exhibited more weight (131.41 g) as compared to Gola (99.68 g) (Table 1).Minimum fruit weight of 'Surahi' in winter was 106.44g on 28th January, 2011. 'Gola' showed maximum fruit weight (112.66g) in 4thsampling duration on 28th January, 2011 (Fig. 2). Minimum fruit weight of 'Gola' in winter (2010-11) was 82.20g on 13th February, 2011 and 67.33g on 9th February, 2012 respectively. On an average 'Surahi' showed significant results in winter as compared to 'Gola' cultivar.

Table 1: Changes in physical fruit parameters of guava cvs. Surahi and Gola during winter and summer crops

Cultivars	Winter				Summer			
	Width (mm)	Length (mm)	Weight (g)	Firmness (lbs)	Width (mm)	Length (mm)	Weight (g)	Firmness (lbs)
Surahi	61.07a	81.64a	131.41a	2.4a	47.85a	49.74a	63.84a	1.60b
Gola	65.21a	62.32b	99.68b	1.6b	47.29a	37.63b	57.63a	2.20a
	NS	*	**	**	NS	*	NS	*

* and NS indicate significant and non-signigicant difference at P≤0.05 respectively.

Table 2: Changes in fruit length (mm) of guava cvs. 'Surahi' and 'Gola' during winter

Cultivars	Winter crop					Mean
	14-Dec	29-Dec	13-Jan	28-Jan	13-Feb	
Surahi	78.99ab	84.53a	84.75a	81.39a	79.53ab	81.64a
Gola	71.97abc	64.08bcd	56.50cd	64.21bcd	54.83d	62.32b
	*	*	*	*	*	*
Mean	75.48a	74.31a	72.80a	70.63a	67.18a	

* indicate significant difference at P≤0.05.

Table 3: Changes in fruit firmness (lbs) of guava cvs. 'Surahi' and 'Gola' during summer crop

Cultivar	Fruit firmness (lbs)					Mean
	25-Aug	10-Sep	26-Sep	12-Oct	27-Oct	
Surahi	1.00b	2.00ab	1.66ab	1.33b	2.00ab	1.60b
Gola	2.66a	1.66ab	2.66a	2.00ab	2.00ab	2.20a
	*	NS	*	*	NS	*
Mean	1.83a	1.83	2.17a	1.66a	2.00a	

*, NS indicate significant and non-significant difference at P≤0.05 respectively

Table 4: Changes in biochemical fruit parameters of guava cvs.Surahi and Gola during winter and summer crops

Cultivars	Winter			Summer		
	SSC (^{o} Brix)	AA (ml 100 $^{-1}$)	T A (ml 100 $^{-1}$)A	SSC (^{o} Brix)	AA (ml 100 $^{-1}$)	TA (ml 100 $^{-1}$)
Surahi	10.81a	277.33a	1.26a	8.78b	192.64b	0.88a
Gola	10.05a	285.65a	0.89b	9.80a	255.62a	0.98a
	NS	NS	*	*	*	NS

* and NS indicate significant and non-signigicant difference at P≤0.05 respectively

Table 5: Changes in fruit TA (%) of guava cvs. Surahi and Gola during winter (2010-11) and winter (2011-12) crops

Cultivar	Winter crop (2010-11)					Mean
	14-Dec	29-Dec	13-Jan	28-Jan	13-Feb	
Surahi	1.20ab	1.35a	1.35a	1.13ab	1.28a	1.26a
Gola	0.58b	1.08ab	0.96ab	0.93ab	0.92ab	0.89b
	*	*	*	NS	*	*
Mean	0.89a	1.22a	1.15a	1.03a	1.10a	

*, NS indicate significant and non-significant difference at P≤0.05

In winter season, the growth intervals for fruit growth increased and increased fruit weight was might be due to increase in sucrose accumulation in the pulp tissues of guava fruits. In summer crop weight decreased due to attack and damaged of fruit fly. While these results were opposite to Thaipong and Boonprakob (2005) which indicated fruit weight of guava in winter (491.9 g) was less than the summer season (560.6 g).

Fruit firmness (lbs): Statistical analysis at 5% level of significance for both cultivars 'Surahi' and 'Gola' in summer crop reflected non-significant differences among sampling periods, while on an average 'Gola' (2.20 lbs) showed significant difference as compared to 'Surahi' (1.60 lbs) as revealed in Table 1. Minimum fruit firmness or maximum fruit softness of guava cv. 'Surahi' (1.00 lbs) was obtained on 25th August, 2011 and 'Gola' (1.66 lbs) was exhibited on 10th September, 2011. Maximum fruit firmness (2.00 lbs) of 'Surahi' was obtained in second and fifth sampling period while (2.66 lbs) of 'Gola' fruit firmness was obtained on 25th August, 2011 and 26th Septeber, 2011 (Table3).

In winter observation regarding firmness revealed non-significant results during sampling periods for both 'Surahi' and 'Gola' while on an average 'Surahi' (2.40 lbs) revealed more significant results as compared to 'Gola' (1.60 lbs). During sampling periods, 'Surahi' and 'Gola' showed maximum firmness (2.66 and 2.00 lbs) on 14th December, 2010 and 13th January, 2011 respectively. Minimum firmness (1.66 lbs) of 'Surahi' obtained on 28th January, 2011. 'Gola' exhibited minimum fruit firmness (1.00 lbs) on 5th sampling duration on 13th February, 2011 (Fig3).During initial stages of development the firmness of guava is due to presence pectic substances. Due to the activity of pectic enzymes the softening of fruit exhibited by degradative changes in the pectic substance (Huber, 1983).

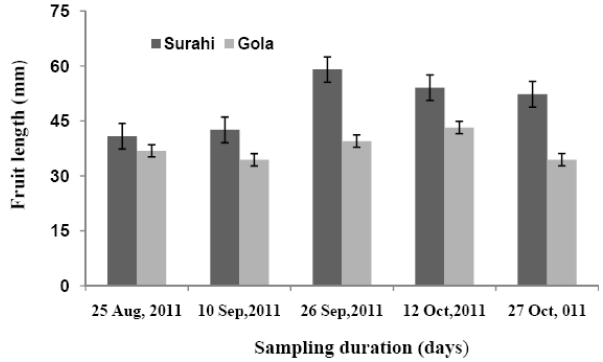

Figure 1. Changes in fruit length (mm) of guava cvs. 'Surahi' and 'Gola' during summer crop. Vertical bar represent ± SE mean. n = 3 replicates.

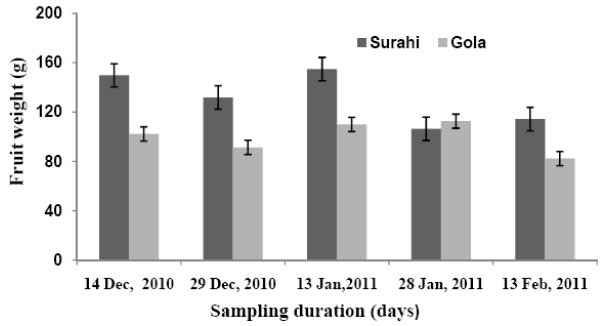

Figure 2. Changes in fruit weight (g) of guava cvs. 'Surahi' and'Gola' during winter (2010-11). Vertical bar represent ± SE mean. n = 3 replicates.

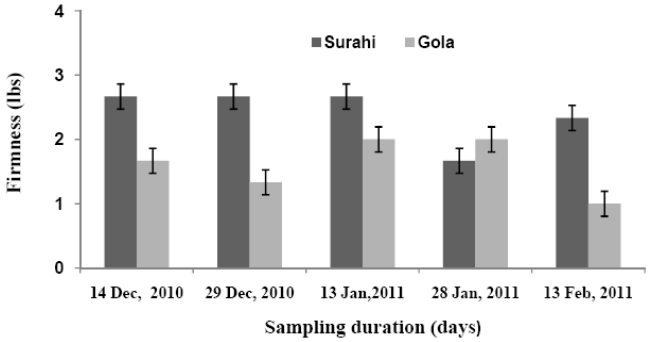

Figure 3. Changes in fruit firmness (lbs) of guava cvs. 'Surahi' and 'Gola' during wintercrop. Vertical bar represent ± SE mean. n = 3 replicates

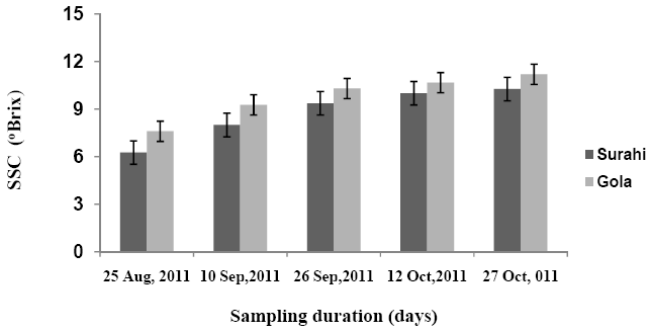

Figure 4. Changes in fruit SSC (°Brix) of guava cvs. Surahi and Gola during summer (2011) crop. Vertical bar represent ± SE mean. n = 3 replicates.

Biochemical parameters

Soluble solid contents (°Brix): Analysis of variance at 5% significance level showed significant differences for SSC of 'Gola' as compared to 'Surahi' cultivar in summer while non-significant differences was found in winter (Table4). Average SSC of 'Gola' was 9.80 °Brix and 8.78°Brix for 'Gola' in summer, whereas, 10.81°Brix and 10.93°Brix of 'Surahi' in winter (2010-11) and winter (2011-12) respectively as compared to 'Gola' cultivar which showed 10.05°Brix in winter (2010-11) and 9.61°Brix in winter (2011-12).During the different intervals of fruit sampling both cultivars showed different trend as in summer season 'Gola' showed maximum (11.20°Brix) at 5th sampling period on 27th October, 2011 while minimum value (7.6 °Brix) showed on 25th August, 2011. 'Surahi' just like 'Gola' revealed maximum soluble solid contents on 27th October, 2011 and minimum SSC on 25th August, 2011. In summer, SSC value increased from 1st sampling period to 5th sampling period (Fig 4). In winter season (2010-11) maximum SSC of Surahi (10.93°Brix) and Gola (10.46 °Brix)was observed 14th December, 2010 while minimum (9.60 °Brix) SSC of Surahion 28th January,2011 and 8.93°Brix on 13th January, 2012.Decrease in SSC might be due to the fact that high moisture contents increase the water contents in fruit and finally it diluted the fruit juice. SSC of Pakistani varieties less than the Indian varieties were might be due to difference in soil and climatic condition (Aulakh, 2004).

Titrable acidity (%): Titrable acidity in summer as shown by Table 4indicated non-significant difference between 'Surahi' and 'Gola' cultivar) while in winter TA showed significant results at 5% significance level.In Table 5 TA of 'Surahi' was 0.88% and 0.98% of 'Gola' in summer season. Minimum TA (0.70%) and 0.83 was observed on 25th August, 2011 and 12th October, 2011 by 'Surahi' and 'Gola' respectively, while the maximum fruit TA (1.06%) was observed by 'Surahi' on 26th September,2011 and 'Gola' showed maximum TA on 27th October, 2011). According to Wills et al. (1989), organic acids usually decline during ripening as they are respired or converted to sugar. Reduction in acidity was mainly due to the result of a decrease in citric acid.

Ascorbic acid (mg 100 g^{-1}): AA of guava cultivars i.e. 'Surahi' and 'Gola' in summer was found significant by different periods of fruit sampling at 5% level of significance while in winter 'Surahi' revealed non-significance difference as compared to 'Gola' cultivar. In summer, maximum AA (729.04 mg 100 g^{-1}) showed by 'Surahi' in first sampling interval (25th August, 2011), while minimum AA (218.09 mg 100 g^{-1}) was observed in 'Surahi' during third sampling interval (10th September, 2011). 'Gola' exhibited maximum AA (279.04 mg 100 g-1) in first sampling interval on 25th August, 2011 (Fig.). Average AA of 'Gola' (255.62 mg 100 g^{-1}) was greater than 'Surahi'

(192.64 mg 100 g^{-1}) (Table 4). The larger variation in ascorbic acid contents may be attributed as a varietal character and due to favourability of seasonal conditions. Ascorbic acid contents increased as soil moisture contents increased and decreased during second week of March when soil moisture was depleted.Ram and Rajput (2000) reported that ascorbic acid increases at high moisture contents instead of decreasing. Maximum ascorbic acid contents 336.34 and 261.51 mg $100^{-1}$was found at 23.30% soil moisture contents during third week of December in 'Sardar' and 'AllaabadSufeda' respectively.

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